

DISCUSSION SESSIONS

Three separate and consecutive discussion sessions were held at the workshop. The topics of these discussions were focussed on Design, Construction and Operations & Maintenance. The questions and issues considered in these sessions are outlined below. Comments from the audience are noted under each bullet. These comments do not necessarily reflect the opinions of the workshop participants, presenters, sponsors or organisers.

The discussions were summarised by each discussion leader to all participants in the closing session of the workshop. Andrew Palmer concluded the technical portion of the workshop. His observations are noted at the end of this section.

1. Design

Leader Jack Clark

- 1) The discussions about design reported various strain limits somewhat arbitrarily selected. More pertinent for offshore pipelines is the limit $KD^2/t = \epsilon D/2t$ which expresses a lower bound on bending strain, above which the pipe may buckle, and the ovality exceeds 2%. These results were established in the 1970s. $K=1/\rho$ is the curvature in the pipe centreline.

For Northstar the absolute lowest strain limit was 2.3%. Even at 5% strain, there was no buckling or increased ovality. Their thick wall pipe did not buckle. This is documented in technical notes.

A large amount of work was also done on TAPS pipeline that has a large D/t ratio and is not like the Northstar pipe.

The DnV code (1966) is actually less conservative in its buckling formulation.

Strain limits should not limit the use of a pipeline subject to large deformations if the integrity and operational serviceability still exists.

- 2) What were the critical engineering design criteria that led to casing the Colville River crossing?

Ans. The risk based management decision was controlled by design, constructability, environmental and economic factors.

A major concern was what would happen if there was a leak – in a normal pipe the leak would never be found due to dispersion into geological strata.

Decision based on circumstances at that time.

Each case should be based on the particular aspects of that period of time – economics and technical innovations may result in different solutions today or in the future.

- 3) Can you repair the leak if one should happen on Colville River Crossing?

Ans. Leak detection is installed. Control fluids. Corrosion allowance. De-oxygenation – Chemical controls. Outside pipe is a coated heavy walled pipe.

Anticipate no leak.

If leak, pull out the carrier pipe is probably the way to go.

If that doesn't work, completely new installation may be required.

- 4) How do you keep the annulus dry?

Ans. It is sealed, keeping it dry could involve a vacuum drying system.

- 5) I question the relevance of lower 48 pipeline failure data for purpose built Arctic applications

Ans. Data is not particularly relevant – brought up for establishing the legitimacy of the concern.

Always on to create a problem when using historical data

Northstar already represents a pipe-in-pipe application, as it is 3 times thicker than it had to be.

Accident statistics – it should not be taken as representing something that should not be recorded?

More than having the data or statistics on failure it is the lessons that can be gathered from these failures.

Option may be to put more steel in the design.

- 6) There seems to be an underling belief that pipe-in-pipe systems are safer than single pipe systems. If there is one lesson the industry has taught us it is that the more complex the design the more likely it is to fail.

Ans. More complex systems have more failure mechanisms but must go through these to see if they occur at the same time.

- 7) Can you get a comparative risk of the two options: pipe-in-pipe vs. single line pipe?

Ans. Difficult to establish reliable statistical numbers for the risk assessment – therefore difficult to do numerically.

- 8) Problems to be addressed by pipe-in-pipe are not necessarily eliminated or are they?

Ans. No, each application must be evaluated on its own particular merits.

Weldable Query – ans. The question should be what are the risks involved? What are the benefits?

Pushing for a quantitative analysis and should have the potential benefit of containment.

What are the best options?

Rhetorical question - What is the objective of having a double pipe in pipe? Requirements must or should address the particular application.

Cannot compare railway or road crossing failures of pipe-in-pipe with this application – no sealing assurances are specifically designed in.

Functional analysis of double wall pipe in pipe – performance parameters and characteristics, costs etc may result in the determination of a single all (very much) thickened pipe.

For the Northstar application, which was the first offshore arctic pipeline, simpler was better.

- 9) Would appreciate information about comparative spill risks of pipelines and barges, The reason is that the Liberty proposal involves transport of diesel fuel to the island by barges during summer and trucks during winter in contrast, the Northstar project involves 2 pipelines and transfer of fuel (gas) to the island through a pipeline.

Ans. Not that difference is inferred.

Gas is the normal fuel. Diesel is for emergencies.

- 10) *Was not the key difference between Alpine, Northstar and Liberty - Arco was willing to overrule engineering in order to get timely permits whereas BPX was looking for an excuse to delay.*

Arco management, seeking timely permits, made the decision to go to a cased river crossing to mitigate the effects of a leak situation. PERIOD.

Secondary containment- also structural integrity.

Primary for secondary containment, not structural integrity.

No comment by Arco representative on the accusation of management overriding an engineering decision.

No comment made on the BP situation – which implies that BP is just looking for an excuse to delay.

Arco – when we could not answer how to clean up a spill or leak under the river – then decision was made to a cased pipeline.

- 11) *What is the MMS perception of the advantages of pipe-in-pipe*

MMS is not going to dictate the design but going to evaluate the merits of the design.

- 12) *Why isn't Intecs report on the 4 different Liberty pipeline designs available for discussion on this session?*

Report was not the focus of this workshop. It was not the objective of this workshop to look at Intecs report.

- 13) *What lessons of double walled pipeline design for Alpine are relevant for Northstar or Liberty situations (presentation did not relate the Colville crossing to potential offshore applications; including problems with loss of drilling muds in the HDD drilling)*

Horizontal drilling instead of the case of a trench. Drilling muds used at Colville for horizontal drilling are not relevant to Northstar or Liberty.

Question really involves a comparison of apples and oranges.

Liberty was designed on the bases of its specific design needs.

The case of horizontal drilling is determined primarily by the 'secc'ability of the soils.

- 14) *Relative to double walled pipelines are the potential applications of containment & leak detection system w/in the annulus outweighed by potential increase risks due to corrosion, construction complexity & lack of pigging or the outside casing*

Experience dictates that general cannot directly be reached or one outweighs the other – must take all design parameters and requirements into consideration.

Is containment the primary concern? If it is then must address other problems that may arise due to the containment being implemented.

Have not found any applications in crude oil transmission where pipe in pipe has been used.

Did not look at river crossings!

No subsea use yet of pipe in pipe offshore pipelines.

Pipe in pipe limits the inspection of the casing or outer pipe. Also you give up some level of corrosion protection and you buy containment.

- 15) *How are companies in the GoM currently dealing with corrosion of outside pipes in double walled designs.*

Cathodic protection, coatings.

- 16) *Consider repair difficulty in evaluating pipeline design – pipe-in-pipe will be impossible/expensive to repair. What about difficulties of any pipelines*

Will be expensive.

Single walled pipe can be repaired – logistical support /equipment may dictate when you can do it.

Same integrity – can get it real close – mechanical connectors.

You can get a welded repair.

Repair of outer pipe – hyperbaric welding may be possible.

- 17) *Any experiences with repair of bundle or pipe in pipe?*

None was known.

- 18) *Is 8 years of ice data enough to develop a 100 year event*

Can see very old scours – relict type and in fill.

Northstar – gouges are not that long-lived.

Abundant amount of ice scour data available that allows for very predictive analyses.

- 19) *Alpine – applicability of Alpine double walled design?*

This has already been addressed.

- 20) *Can we design a subsea pipeline to eliminate the risk of ice contact (gouge below level of pipeline)*

Three zones are considered. The top one interacts by the ice. The second lower zone is disturbed by ice presence, and may be where pipe is placed.

- 21) *Secondary containment with plastic pipe – how would it respond to modest ice gouging*

Return period for 7 foot burial is several million years.

Plastic pipe is too flexible – will not provide secondary containment – it does not have as much pressure containment at the point of leakage,

Problem of cathodic protection.

Would not recommend a plastic pipe as the secondary containment.

- 21) *Drake Point F76*

Never any intent to pay for costs through production.

Demonstration project to show capability to produce gas from the arctic.

2. Construction

Leader Carl Langner

- 1) Discussion emphasised the particulars of the Northstar and Liberty pipeline projects. Other Arctic pipeline issues discussed to some extent.
- 2) *Would like more information on situations in which long directional wells (essentially underground pipelines) have been drilled in ice bonded permafrost, Tom Newbury MMS*
 - Option of directional drilling to access reservoir from onshore an/or directionally drilling to access an offshore production facility.
 - Permafrost substrate application? Difficult to drill
 - Mud selection a critical factor? Oil based mud may not be permitted.
 - Distance may be limited to about 10km. May require intermediate traction devices not yet developed.
- 3) Options to armour the trench as a protection of the pipeline from external trauma. Options include some type of concrete cover, or freeze pipes arrayed above and to each side of pipelines, which form a freeze ball around the pipe.
- 4) There has not been nearly enough said about material selection, or about pipe and weld inspection, which are at least as important as corrosion and leak monitoring
 - material selection and weld inspection
 - Material selection needs to have a good connection with project designers.
 - Emphasise putting as much quality into pipe selection, welding and inspection technology; as in monitoring corrosion and leaks
 - All rods from a single batch
 - A viable means to enhance pipeline integrity
 - No repairs during construction offshore
 - X-ray and UT will be used on Northstar
- 5) If the line is installed by pull or conventional lower-in method pipe in pipe assembly could be constructed on ice
- 6) Cathodic protection complex in pipe in pipe applications. May require coating all steel surfaces and leaving annulus filled with dry nitrogen gas.
- 7) Definition of carrier pipe
 - retire term. Use inner pipe for flow line etc. Use outer pipe for casing etc.
- 8) What method of NDT inspection can be used on casing pipe welds
 - inner pipe of pipe in pipe, or single pipe, can always be inspected by x-ray or UT or both. Outer pipe can always be UT'd but can only be X-rayed if inner and outer pipes are welded separately and then slid together.
 - Northstar welds will be inspected by both x-ray and UT
 - Northstar project will not allow weld repairs. Defective welds will be cut out and re-welded.
 - Inspection should extend beyond welding to coating and CP systems
- 9) What are the obstacles to directionally drill the 6 mile 10" pipelines? Can R&D overcome these obstacles?
 - weld technology limits directional drill feasibility.
 - Recommend funding R&D into HDD technology for Arctic
- 10) Focus seems to have been on small diameter oil pipelines with their associated risk etc. What are the issues surrounding the potential construction of large diameter Gas pipelines in the offshore regions of

Alaska/Canada? Footnote: Natural gas pipeline between US & Canada will never happen off coast of Arctic National Wildlife Refuge.
- lets walk before we run

- 11) What problems, if any, were encountered in the installation of double walled pipeline for the Alpine under the river. What solutions if any were found for these problems. What is the current state of the outer pipeline?
 - lesson of drilling through permafrost and insulation
- 12) Pipeline insulation options in permafrost. How to include active cooling as well as insulation
- 13) Trenching a ditch allows you to see /know what you are running through
- 14) How far cans directional drilling in the Arctic be done technically/economically? What are the limits in the Arctic that we don't see elsewhere?
 - this question is answered above

3. Operations & Maintenance

Leader Bob Bea

- 1) What type of rules or guidelines will be followed for decommissioning of pipelines in Alaska's OCR and State waters? Will pipelines be similar to those for the GoM and North Sea?
- 2) How will this effect design and installation?

1 & 2) Aleskya has decommissioned sections of TAPS by cleaning out product and capping pipe ends, then leaving pipe buried. Onshore examples of decommissioned pipes were discussed, e.g. the Whitepass Skagway pipeline from BC to US has not been removed due to concern over environmental damage caused by removal. Permittors are leaving option open by granting suspension rather than abandonment permits. In valuable right of ways, there may be a future requirement to remove pipes to allow redevelopment. In GoM, a lot of pipes are decommissioned and left in place.

- 3) How can the casing pipe be inspected since external corrosion fails for more pipelines than internal?

Corrosion can be detected by magnetic flux leakage (MFL) or ultrasonic techniques. The MFL method is unable to magnetise the outer wall of PiP due to air gap. Ultrasonics would only work if the air gap was very small. The consensus was that there is currently no effective means of monitoring corrosion of outer pipe.

- 4) Shouldn't we consider pipeline REPAIR technology during the design process for new pipelines? How do we repair pipe-in-pipe in a subsea / Arctic setting? How do you repair any of the pipeline systems in this situation?

- In double hulled ships repairs are very difficult. Subsea pipeline repairs are very difficult offshore and extremely difficult in Arctic.
- Cased crossings have repair technique possibility – pull out inner pipe, repair and replace.
- Well analogy – routinely pull tubing eg 4" from 24,000' well
- Challenge length, accessibility (cant get to both ends) inner pipe, what about outer pipe damage
- PiP conceived to have spacers
- Casing leaks – packers to squeeze off, sleeves, internal liners (straddle pack) wells designed to do that

- 5) How do combined risks of natural gas explosion and crude oil pipelines affect operations and design?

- gas is a human safety issue, oil is environmental issue, different consequences. What is value of human life, what is value of environmental damage. If access is only 6 to 8 months, if spill is irretrievable. Informed

consent - on North Slope no one there, for Valdez there is risk to town and innocent bystanders. Assessing the risk is not the same as communicating risk.

- Consequences, consider spill x spread x receptor x product volatility (eg benign)
- 6) LEOS: to what extent is this an Arctic 'pilot' test and has it been used in arctic temperatures, salt water, subsea?
- 20 years of operation. Max length 8 km in operation, improve to 10km, only for buried or cased pipelines, in Rhine in deeper water, will be modified for intended environment. First application offshore. 1 day /measurement. 6 hours to take each measurement.
- 7) Do we need to pig the outer casing of a double walled line to monitor it?
- For large outer diameter – crawl through. Also could pull inner pipe and then inspect outer.
- 8) Is the B31G code good?
- Good but very conservative. But if remove factor of safety then may feel uncomfortable. RAM program includes 151 tests, found no correlation for corrosion allowance to area parameter. Metal loss corrosion is different between machined and natural defects. Residual stresses in pipe from machined defects, so etch defects in test pieces.
- 9) Does Alaska have the best maintained pipelines in the world
- Alaskan pipeline are not at end of bath tub curve, with increase failure rates, except perhaps Cook inlet pipelines from 1968 on. Cathodic protection may be challenge in weird soils. Operations show very good conditions all things considered, remember these pipes are over designed.
 - 1×10^{-3} failures /year – failure rate riser to riser – is similar for both MMS and Norwegian Petroleum Directorate data – even to recent increase due to decrease in inspection with time. Main causes – corrosion and anchors & spuds.
 - Pipeline leak before pipe rupture – different design concern to other pipes.
 - Risk controlled by maintenance
 - Consciousness / alertness of operating companies makes big difference
 - A State position – cutbacks concern in companies – people, prevention, spill response
 - Cook Inlet pipes are at 4 x times design life.
 - TAPS – one section worn out 5 yrs ago. Use of liners – conduit (done already over 6ml length)
 - Alyeska monitoring – monitor change in wall thickness – repairs before failure.
 - As pipeline life increases, throughput decreases, so costs allocated for maintenance are less, but this is time important to monitor, check ups, on bath tub curve end.
 - Inline inspection – need sensor improvement, defect smaller than sensor footprint, concern.
 - RAM program results is accessible through MMS. Unocal will do POP test in Spring. James Wiseman provided overview of POP program, MMS is a sponsor.
- 10) What constitutes failure of a pipe-in-pipe (double wall pipeline)
- Any component failure in PiP is failure
 - This was considered a very demanding criteria- might cause polarisation of opinion.
 - State has not defined failure. Need leak detection system.
 - Zero defects is goal – maybe achievable in 20 years time – no accidents – reduce safety/reliability – cycle
 - What is purpose of 2nd wall? Impact resistance or double containment. There will be a significant time before performance function can be verified.
 - Offshore oil PiP application now in place NOT for containment, but thermal and carrier (bundle) considerations.
- 11) Cathodic protection and corrosion protection of a double wall pipeline

- care: good idea – undesirable consequences. Study of new technology is good, but remember question – does it give safer pipe?
 - In long term, what is direction of Beaufort developments?
 - CP is nightmare in PiP
- 12) Design & regulatory criteria for Northstar, but question if gone through North Sea operations, but didn't hear this mentioned in workshop so far.
- talk to each other at workshops like this,
- 13) Valves – do they increase or decrease risk to pipeline operations?
- Probability of failure may increase or decrease. More things to go wrong, but also more information. “Killed by your own armour”

4. Concluding Observations

Andrew Palmer

The workshop topic has been well addressed. This workshop serves as an example to Europe and elsewhere on how to create an informed community.

- 1) A statement was made “If you do not have a number, you do not have a fact, you have an opinion”. This is dangerous. What is the source of the number? There is pressure to obtain a number for example for risk analyses. However, is it just mathematics, or does it involve data, judgement or extrapolation? Be careful, you could have “a number pretending to be a fact, which is actually just an opinion”.
- 2) Bob Bea presented an analysis of observed offshore oil mishaps. This data was considered insightful.
- 3) Bill Fowlow and Martin Thurlow of Arco clearly explained the reasoning behind the Colville River crossing in a step by step, scenario based way.
- 4) There are more than 5 pipe in pipe systems in the Gulf of Mexico and over 20 in the North Sea; some have been in use for more than 15 years. Some have quite simple configurations, some have quite complex configurations, for example the Gannett bundle has 14 internal lines. None of these have been used for containment. Their apparently satisfactory performance to date provides some degree of confidence, and may indicate an acceptable level of safety. There will be a need to look closely at the scenarios for the application for containment. ‘If x happens, what action can be taken?’ In medical testing, there is an awareness of false positive and false negative test implications. We need to consider the same. There are scenarios in which PiP may have given enhanced safety against containment, such as the oil release from a single walled pipe under the Mersey estuary.
- 5) The regulatory process is an imperfect process, like all human activities. This process is improved through informed discussion, an expansion of knowledge and involvement of the whole community. The workshop was very valuable in these respects.